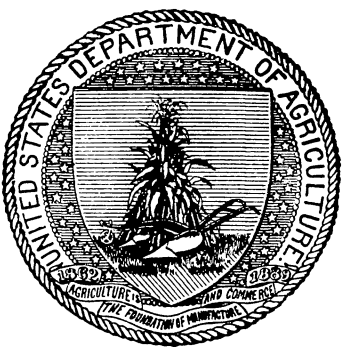
U. S. DEPARTMENT OF AGRICULTURE.

FARMERS' BULLETIN No. 236.

INCUBATION AND INCUBATORS.

BY

RICHARD H. WOOD, M. D.



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LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF ANIMAL INDUSTRY,
Washington, D. C., October 25, 1905.

SIR: The large and constant demand for information concerning incubators led to the publication in the Twenty-first Annual Report of this Bureau of an article entitled "Incubation and Incubators," by Richard H. Wood, M. D. It seems desirable to publish this article separately for use by those people who do not possess a copy of the complete report, and I therefore recommend its publication as a Farmers' Bulletin.

Respectfully,

A. D. MELVIN,
Acting Chief of Bureau.

Hon. JAMES WILSON,
Secretary of Agriculture.

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PRELIMINARY REMARKS.

During the past century great progress has been made in nearly all lines of agriculture, and poultry raising, now recognized as an important branch of agriculture, has advanced with other lines. It has become a trade, an art, and a profession. Nor has any other nation made greater progress in poultry raising than has the United States. Poultry raising has been given abundant space in our agricultural journals and place in our leading agricultural colleges.

This article deals entirely and exclusively with the hatching of eggs, or incubation, natural and artificial, and to be complete it must treat of both the egg itself and the means employed in hatching.

Many farmers regard the incubator proposition as one out of their line of study and practice. To them natural incubation is too simple to demand consideration and artificial incubation is too complicated for anyone but an expert. To bring the farmer into closer sympathy with this article it may be well to state that the writer has taken a great and active interest in the subject of incubation for the past thirty years; and, while he has been successful, he has made some failures and met with some disappointments, just as others have done and as many will do until by study and practice they acquire that skill which after all is fully as necessary to success in other lines as in this.

IMPORTANCE OF THE INCUBATOR.

Poultry raising is one of the important features of farm work. The incubator is an important factor in poultry raising. It is a success; it has come to stay; and the time is not far distant when it will be as necessary upon every farm as is the plow, the mower, or the separator. It is a machine the operation of which is simple. It calls for no hard or heavy manual labor. A woman, a child, or even a crippled or invalid member of the household may learn to operate an incubator easily and successfully. To make this possible and to bring a practical knowledge of this subject to every farmer or other interested person in our land, is the aim of this article.

In order to make this article of the greatest value to all, it must appeal to the manufacturers of incubators as well as to the users of them. Hundreds of most excellent incubators are being made and sold, but they are forced to compete with almost as many that are inferior and imperfect if not positively defective. Now, every imperfect machine put out is a serious damage to the incubator business. The purchaser of an inferior machine, failing to secure good results, sets aside his incubator and informs his neighbors that artificial incubation is a failure. On the other hand, the purchaser of a good machine—one properly made and adapted to its work—is so apt to be pleased with his success that he encourages his friends and neighbors to undertake raising chickens with incubators. At this point it seems proper to answer the question, asked so frequently, "Is there not some danger that so many will embark in this business that it will be overdone, and the markets be overcrowded with poultry and eggs?" Answer: No; the demand is constantly increasing, and more production will be followed by increased consumption. As fast as a regular supply can be depended upon, to the same extent will consumers learn to avail themselves of that supply.

Again, not everyone who has gone into the poultry business will remain in it. Many will not find it to their liking, while others will not have sufficient energy and persistence to learn its details. The poultry business is one of the most stable lines of business in the world to-day. Its products are always in demand in every town and city in the world. No prejudice of religion or caste stands in its way. Sales are not limited as to locality or season. When the use of the incubator becomes known, when farmers generally become acquainted with its management and its many advantages, then will the public learn that the supply of poultry products is regular, and then will the use of these products be greatly increased.

A STUDY OF EGGS FOR INCUBATION.

First in order, then, comes the study of the egg itself. The writer does not propose to enter into an essay upon embryology. It will be sufficient for our purpose to say that the egg must be fertile, or hatchable, and this brings us at once to the subject of fertility.

An egg receives its fertility from the male bird, but the condition of the female at the time of laying has much to do with the hatching quality of the egg. This should not be regarded as a statement of a far-fetched notion, but as a fact that has been noted and demonstrated time and time again in the writer's own experience. The laying hen must be healthy and properly fed or she can not produce an egg capable of carrying the germ to a successful hatch. Hens kept in unhealthful quarters or too closely confined are not likely to lay eggs

that will produce strong, healthy chickens, if indeed they produce any whatever. Hens suffering from disease or infested with vermin may lay, but eggs from such hens will rarely hatch, and even if they do hatch the chicks will not be likely to mature into vigorous or growthy fowls. Hence in order to secure hatchable eggs the hens must be healthy, have plenty of outdoor exercise, and be fed upon an assorted or balanced ration. An exclusive corn diet will not make for fertility. Fowls in confinement must have a mixed diet and plenty of grit and bone, with meats, clovers, or other substances in the line of nitrogenous food. They must be kept free from lice and must have plenty of litter, straw, hay, chaff, or leaves in which to scratch. Fowls having free runs need less attention to diet and are more apt to lay fertile eggs than fowls closely imprisoned. Many different ideas prevail as to the number of hens that should be allowed to a cock. In this matter much depends upon the breed of fowls, much depends upon the way the fowls are kept, and much depends upon their ages and condition. One should exercise some oversight as to the matings of his fowls and regulate the size of his breeding pens accordingly. With most breeds we get a larger percentage of fertile eggs from a mating of a number from ten to twelve hens to one cock. Eggs may be fairly safe from a pen of twenty hens with one good, vigorous, young male bird. Some advise keeping but two or three hens with a cock, but in the writer's experience such matings are generally unsatisfactory. The male will so worry and annoy his small flock that but few eggs will be produced and few of them will be fertile. Besides this, two or three hens confined in this way are apt to become jealous, nervous, and quarrelsome. The same cock, if given a larger flock, will keep them harmonious and contented. With these ideas in mind it is safe to recommend that a breeding pen shall consist of from seven to fifteen hens and one cock, and the latter should be strongly bred, in good health, and known to be vigorous. But some recommend keeping more than one male bird in a flock. This may do, but where this is done it is wise to have a comfortable and convenient coop in which to keep one of the cocks, and then by a system of catching up one cock and releasing the other every night give each one alternately a day of rest or a day upon the walk. Another advantage in this system is that the cock has a chance to feed by himself part of the time and can be kept in a more thrifty and vigorous condition than if upon the walk all of the time.

It is highly necessary that the amateur or the novice shall be impressed with the fact that the fowls from which eggs are saved for hatching must be strictly healthy, must have a reasonable amount of exercise in the open air, besides an abundance of strictly fresh and pure water, and a great variety of wholesome food. Even under

the most favorable circumstances the eggs will vary to the extent that there is room for selection. Select eggs of a medium size and an average as to color and shape. Let the selection be influenced by the average product of the hen or breed. An unusually large egg for the breed or hen may be a monstrosity and can not be expected to hatch. An unusually small egg may be defective and should not be incubated. An egg of unusual length or one of unusual rotundity should not be placed under a hen nor in an incubator. An even, uniform lot, assorted as to size, color, and shape, will be apt to give the best results. Freshness is a prime necessity. While an egg six weeks old may hatch, the chick will be weak and hard to raise. Fresh eggs hatch earlier, and the chicks from them are stronger than those from older eggs. As a rule, eggs more than twelve days old should not be placed in an incubator. This is one of the reasons why eggs from a flock numbering from ten to twelve hens are more apt to hatch than are eggs from a flock of only three or four hens. They do not have to be stored so long before getting a sufficient number for a setting. Eggs for hatching should be clean; if not clean they should be washed in tepid water and carefully dried with a clean, soft cloth. This washing does not injure the egg, but it must be done quickly and carefully, or the jarring of the contents may ruin it for hatching. As fast as the eggs are washed and dried they should be covered with a layer of clean cloth or absorbent cotton to prevent their becoming chilled. It is good practice to stand the eggs in a cool quiet place, each with the large end uppermost, for a period of twelve hours before placing for incubation. This balances the yolk in the center and locates the air cell.

In this connection it is well to bear in mind that eggs laid the day they are set will hatch several hours earlier than those that are a week older.

Eggs waiting for incubation should be kept at a temperature of about 60° F., although they will stand a variation of temperature from 40° to 100° F. They should not be allowed to dry out, nor should they be exposed to a current of cold air, steam, or vapor. During storage, eggs for incubator use should be partly turned every day. A little attention to these simple directions will make quite a difference in the possibilities of fertile eggs and will greatly augment the percentage of chicks.

It is poor practice to set eggs of more than one kind or breed together in the same machine, for eggs of different kinds vary in thickness and strength of shell and in the amount of heat and moisture required.

So much, then, for the subject of fertility, all of which can be summarized in the following brief maxims: The breeding stock must be

healthy and properly fed, watered, and exercised. Eggs must be carefully and promptly gathered and cared for. The egg has as much to do with the result of incubation as has the incubator. The machine should not be blamed for failing to hatch a defective egg.

INCUBATION.

The history of incubation is rather obscure. Natural incubation, which is dependent upon the instinct of the mother hen, seems to be conducted by the modern hen in just about the same manner as that of the barnyard fowl of fifty or more years ago. Artificial incubation, or hatching by machinery, is known to be an old idea, and yet very little information upon original processes is to be found in our libraries. Eggs were hatched by artificial means centuries ago. Machines were invented and used successfully for this purpose by the Egyptians long before the Christian era. Very recently some of these hatching ovens have been found by explorers. Some of them depended upon the customary fuel for their supply of heat, while others relied upon stones heated in the sun, and some, even, were found that obtained the necessary heat from lamps. Besides the above sources of incubation heat, mention can be made of decomposing animal and vegetable matter used long ago with unknown success. Not many winters ago the writer had the pleasure of forking out a live and healthy chicken from a heap of compost near the door of his stable. Numerous other instances of accidental incubation have been related, and man's ingenuity has been exercised to devise machines and methods that will insure the transition of the dormant egg into the living chick.

The whole theory of incubation is based upon the fact that, if a fertile egg is kept for a sufficient period of time under certain conditions of heat, moisture, and position, it will be transformed into a healthy fowl.

The period of incubation varies with different species of fowls. The average period of natural incubation is a little over twenty, or about twenty-one days, for the egg of the common hen. This period may be somewhat shortened or prolonged by variations in the conduct of the mother hen, and possibly by changes in the weather. Should the weather be moderate and the hen quiet and faithful, we need not be surprised if the eggs are all hatched by the close of the twentieth or even the nineteenth day. Again, if the weather be extreme or the hen restless and neglectful, we need not look for all the eggs to hatch until the close of the twenty-first or the beginning of the twenty-second day. The same applies to eggs from other fowls, except, of course, that each has its own period of incubation,

subject to the variations mentioned. The following table is accepted by most poultry men and writers upon natural history and is approximately correct:

Period of incubation.

Name of fowl.	Days.	Name of fowl.	Days.
Common hen	21	Goose	30
Pheasant	25	Partridge	24
Duck, common	28	Duck, Barbary	30
Peafowl	28	Turkey	28
Guinea	25		

In spite of all notions to the contrary, the process of hatching can be suspended and held in check for several days without total destruction of the germ. This fact is of practical importance and, if remembered, may save the breeder a good hatch when, because of some accident or oversight, a lot of eggs has been left without outside heat and allowed to cool. Such eggs, if placed at a proper temperature, may hatch fairly well, provided this temperature is maintained a few days longer than the usual period of incubation. The writer has known hatching to be delayed to the twenty-second and, in one instance, until the twenty-fourth day by accidents to his incubators. Hence, where accidents of this kind occur it is wise to keep the eggs warm a day or two overtime, with the expectation that, while incubation may be delayed, the germ is still alive and will develop. This brings to mind one of the greatest advantages of the incubator to the farmer or the farmer's wife—to people who are accustomed to rely upon the mother hen and prefer to raise chickens by natural incubation. Many times the hen will get sick, will die, or without any apparent excuse will leave the nest, and unless another hen is ready to take her place the eggs will spoil. A small incubator in the house will be found useful upon such occasions. The eggs can be removed from the nest and placed in the warm incubator and hatched or kept there until another hen is ready to take up the work. For this purpose alone an incubator is worth its price to any farmer who raises poultry. Many times has the writer saved valuable clutches of eggs by the use of one of these machines when it was found some perverse hen had deliberately abandoned her nest.

THE INCUBATOR.

The egg, its fertility, and period of incubation being now disposed of, the next item for consideration is the machine used in artificial hatching, or the incubator. There are so many different kinds of machines used in hatching eggs that a description of all of them is

quite impossible in an article of this kind. At the present time they are all constructed upon similar principles and along the same lines, and nearly all of them derive their heat from lamps that burn kerosene. In some of the hot-air machines the heat is applied through the medium of heated air, while in others—the hot-water machines—the eggs are supplied with heat from pipes filled with hot water.

HOT-AIR INCUBATOR.

In the hot-air incubator a common kerosene lamp is used to furnish the current of hot air which passes over and around the egg chamber and which keeps the eggs at the proper temperature for hatching. Like the hot-water machine, it is supplied with a regulator, which, acting upon a valve or damper, regulates the admission of heat to the egg chamber.

HOT-WATER INCUBATOR.

In this incubator water is heated and forced through metal tubes over the eggs, thus distributing heat throughout the egg chamber. It is supplied with a regulator which works upon the same principle as does that of the hot-air machine.

PARTS OF AN INCUBATOR.

The selection of the lamp is so important that the writer deems it his duty to warn all poultry men against buying a poor lamp. Manufacturers, as well as purchasers, should remember that while the lamp is half the incubator the burner is half the lamp.

Reservoir of the lamp.—Some remarks on the different parts of an incubator are now in order. First, let us consider the lamp, which is the primary source of heat in both hot-air and hot-water machines. Many kinds of lamps have been tried and many patents have been granted upon lamps and parts thereof for incubator use, but the tendency is to discard all that are in any manner complicated and to return to the plain, old-fashioned burner and chimney. The oil reservoir should be made of metal, either copper or galvanized iron, as those made of glass are too liable to break and are too heavy to handle conveniently. This reservoir should have a flat bottom and a flat top. It should have a capacity exceeding the twenty-four hours' demand of the machine. This is very important, for sometimes it happens that the operator is detained for some reason and can not reach his machine at the proper hour, and in such a case the lamp must contain oil enough for a few hours overtime. This reservoir should be plain and smooth outside and inside. It should be well made and well finished, having no rough projections or slivers of metal or solder to catch the hands, the clothing, or the cleaning cloths. Attached to

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this reservoir, or body of the lamp, should be a good, strong handle large enough for the hand of the operator. Better no handle at all than one that is slender, sharp-edged, flimsily attached, or too small for the use of more than one or two fingers. Select a lamp with a handle that is broad, strong, smooth, and firmly attached. The lamp is for use, and it should be built to stand handling. It must be strong in order that it may be convenient.

Burner.—The burner is the very important part of an incubator lamp. It should be made with the greatest regard to stability and accuracy. The flat-wick tube is the most common, and, when the burner is properly constructed, it answers every purpose. But many manufacturers are careless about the quality of their burners, and are sending out flimsy and poorly made articles that are difficult to manipulate and are imperfect in action. A little carelessness in selecting a burner has led to the condemnation of many a good incubator. The burner should be made of good material, such as brass or copper, and never of poor material, such as iron or plated tin. The wheel or lever used in raising and lowering the wick must be stout, large enough for its purpose, easy to find, and must turn exactly and easily. Never waste any time upon a burner that does not work promptly and readily, so far as the wick is concerned. If it turns hard, or does not turn to the thirty-second of an inch, it is useless and will cause trouble.

The tube holding the wick should be strongly made of material that will not break, spring, or bend, and it should be so adjusted to the size of the wicks furnished with the outfit that the wick can pass up and down freely without pinching or binding. On the other hand, it should not be so large or loose as to allow the escape of gas along the side of the wick. In one case the pinching of the wick will interfere with capillary attraction, and in the other the looseness of the wick will cause an uncertain or unsteady flame. The wick tube should be perfectly true and smooth across the top. A rough edge with notches, depressions, or projections of metal or brazing will make it difficult to trim the wick; and a poorly trimmed wick gives off an uncertain degree of heat. Alongside the wick should be a small tube for the escape of surplus gas or vapors from the reservoir, but this tube must never project above or even to the top of the wick tube, for if it does it will interfere with trimming and be likely to fill with cinder or soot.

Herewith (fig. 1) is an illustration of a burner that is well constructed and has given excellent satisfaction.

The space under the wick screen should be wide open. The hinge to the cap should be very strong and work freely to the fullest extent. The snap, or catch, to the cap should have proper strength and ten-

sion, and should fasten the wick cap firmly to the burner. Every detail should be examined before the burner is sold. The following questions should be settled before the lamp is packed for shipment: Does it leak? Does it fit? Does the elevator turn easily and accurately? Is the wick tube perfect? Is the top of the wick tube level and smooth? Can the wick be trimmed nicely? Has the burner a chimney that has been made to fit? Does the screw or snap that fastens the chimney work easily and properly? Does the thread of the burner fit the thread in the socket of the lamp? This last question may seem unnecessary, but the writer has purchased incubators having burners which could not be turned into the lamp. All these little matters count and have much to do with the success or failure of the hatch.

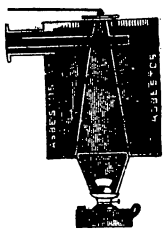

FIG. 1.—Sectional view of a good lamp.

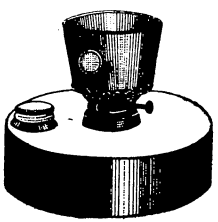

FIG. 2.—One of the best chimneys.

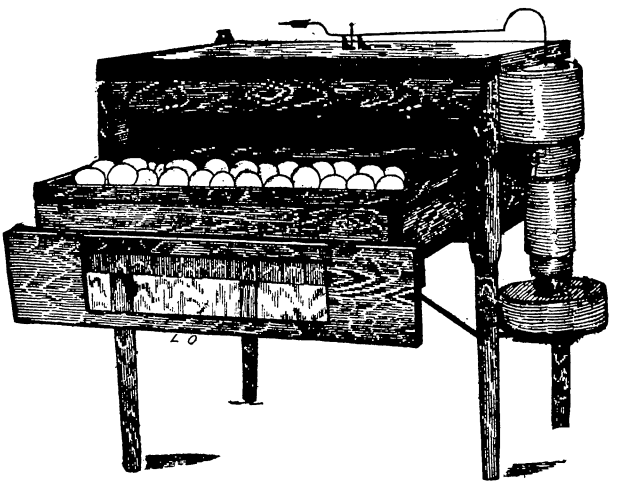

FIG. 3.—A good lamp in position.

While some of the imperfections of a lamp are visible, others can not be discovered until an attempt is made to use the lamp in heating an incubator, or to clean, trim, and fill it. Figure 1 shows a good lamp.

Chimney.—The chimneys of different makes of incubators vary greatly in form. Few are well made, whatever their shape. The base or lower circumference should be smooth and level. The spiral or bevel of conical chimneys should be so cut that the chimney stands plumb when on the lamp. The top circumference should be smooth and without slivers upon the edge to cut the hands or catch the cloth in cleaning. The mica front should be large enough to show the full width and height of the flame, and this mica should be fastened neatly and securely. Allowance should be made for contraction and expansion. Referring again to the forms of chimneys, the writer

has derived most satisfaction from those of a cylindrical outline. They are preferred to those of a conical outline, although those of the inverted-cone form are convenient to handle and, because of their wide, open tops and short canal, very easy to clean. Figure 2 is an illustration of a most excellent chimney.

Nearly every incubator catalogue describes its lamp in glowing terms, but a large number of the lamps sold are useless and discredit their manufacturers. It would cost but little more to make them better, and, if they were properly inspected and tested before shipment, it would hardly be necessary to devote so much space to this subject.

Wick.—Nothing has been found yet that takes the place of the plain cotton wick. Other materials have been tried in the so-called "wickless machines," but while wicks of these new materials are more durable than cotton, they need about the same attention in cleaning if not in trimming. The wick should be of medium weave and some firmness and be made to fit the burner in which it is to be used.

Body of the incubator.—The body of an incubator should be mounted upon good strong legs and at a reasonable height from the floor. If too high or too low, the machine is very inconvenient to operate. The writer prefers that the top of the incubator be about 36 inches from the floor. Manufacturers of incubators should remember that these machines are moved about and are sometimes required to carry weight, and they should furnish them with legs for utility rather than for ornament. The body of an incubator should be made of nonshrinkable material and should be air-tight and have well-fitted joints. None but the very best of workmen should be allowed to work upon an incubator. More depends upon a good carpenter than upon a good painter, and the value of any incubator lies, not in how well does it look, but in how well it is made. The walls of the body should be three in number, making two air spaces, and each of these three walls should be well constructed and with good tight joints. If each of these walls is not tightly made, then the manufacturer should not boast of his air spaces, for an open space can not be called an air space. The outside surface of the body should be of smooth finish. Seams, fluting, beadwork, and unnecessary ornamentation should be avoided. It is easy to see how vermin can infest an incubator that is made of beaded matching. The top of an incubator should be smooth and unincumbered. It is useful as a work table in testing, cooling, or turning eggs, and it should be a clear, free surface. It is quite an inconvenience to have part of the regulator upon the top of the machine. A good feature of some incubators is that they have the regulator either at the end of the machine or under cover, if at the top of the table.

The inside of an incubator, or the space known as the egg chamber, should be well finished. No bad joints and no slivers or other evidences of bad workmanship are allowable. The trays should be smooth, well made, and should slide easily upon the tracks. If the trays stick or hang when being drawn out or pushed in, the machine is defective and should not be accepted by the purchaser. Such a defect will not cause loss of time and patience merely, but it may cause the loss of a trayful of eggs. The space called the " egg chamber " should be deep enough from above downward, or, as carpenters express it, " high enough between joints," that the trays and eggs have plenty of space, and so that when necessary the hand or thermometer can be passed back over the eggs. This is important. There should be at least 3½ inches space between the top of the eggs and the heating tank. Convenience and evenness of temperature both demand that the top of the eggs should not be too near the source of heat. Besides this point, the air around the eggs will be better because of this space.

The nursery, or chick, space below the trays should be ample. From the bottom of the tray to the floor of the nursery should be a space of nearly 4 inches. This space will give the chicks in the nursery a chance to stand erect and also allow the trays to be moved in or out without danger to the youngsters below. One of our best incubators is faulty in this respect, and, while it is a very successful hatcher, it decapitates or otherwise injures several of the chicks every time the tray is drawn out or replaced. Better no space below than a space that is too limited. The removable nursery is one of the most valuable improvements that has been made in incubator attachments for many years, and all who have used it agree that no machine is complete without it. It gives an abundance of room for the chicks as they drop from the tray above and it permits the removal of the chicks from the nursery without disturbing any unhatched eggs that may be left in the tray. The bottom of the nursery is covered with a canvas carpet so that the chicks will not be lamed or injured by slipping. The floor of the removable nursery is usually attached to the front of the egg chamber at right angles and in such a way that the whole nursery can be drawn out as easily as one usually pulls out the drawer of his desk. Such an arrangement makes cleaning and inspection easy, besides giving one access to the chicks in cases of partial or delayed hatches. It also makes it possible to use the nursery to its greatest advantage. The first twenty-four hours are very important ones in the life of a chick, and a properly constructed removable nursery is the best place that has been found for its safety and welfare. The illustration (fig. 4) represents a movable nursery.

Although allusion has been made in the preceding lines to the tray, still a few more words seem necessary before passing the subject. The tray should be strongly made of well-dressed material well put together. It should not spring nor sag when loaded with eggs. It should be made of soft wood, and the nails and screws used should be long enough to hold the parts firmly together. A flimsy or poorly made tray is to be avoided. It means loss of time and loss of eggs by breaking. The writer once bought an incubator the trays of which were put together with carpet tacks and screws too short to hold the different parts in position. The attempt to use was accompanied by the loss of nearly a trayful of eggs, and he hopes that his readers will profit by his experience and examine all trays carefully before

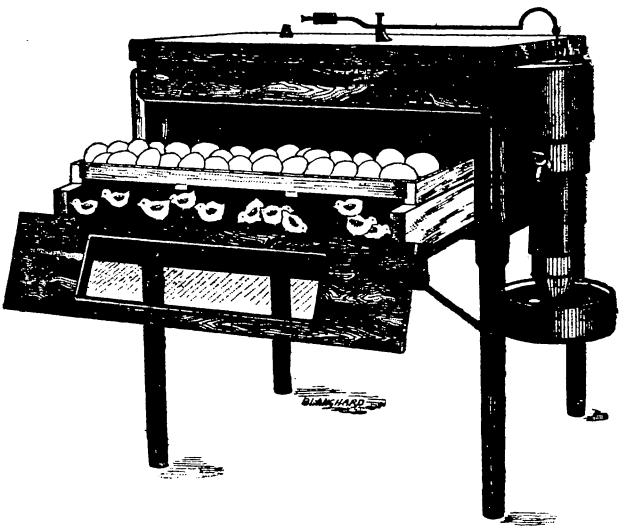

FIG. 4.—Removable chick tray and nursery—an indispensable adjunct.

setting up a new incubator. Many trays are partitioned by wire into small spaces, each capable of holding five or six eggs. As a rule such trays are unsatisfactory. A simple division by three-cornered wooden strips into transverse rows or ranks is highly satisfactory, and it is preferable to any other form of tray. The edged strips of wood stiffen the tray without encumbering it, they take up no egg room, and do not interfere with the process of turning. The tray must not be allowed to slide all the way back against the wall of the egg chamber. A space of at least 2½ inches should be allowed between the tray and the back wall of the machine. A block should be fastened to the top of the track at its farther end to prevent the operator from forcing the tray back and closing up this space. This is important, as the chicks are apt to be pinched, crippled, or killed if the tray

can be pushed too far back. A similar space should be allowed between the front edge of the egg tray and the door. The chick needs this space when it drops from the tray to the nursery.

Returning to our consideration of the body of the incubator, much can be said about the arrangement of the door, or hinged window, in front. Select a machine with a double-glass door. The two layers of glass must have 1 inch of space between them so that they can be cleaned. Many manufacturers are careless about the fit of the door. It should open and close easily, but snugly. If it does not open and close easily, one is liable to jar the eggs and disturb the level of the incubator. The sash of the door should be heavy enough for strength, but not so wide as to interfere with the view of the eggs or the thermometer. The glass in the door should be wide enough in the perpendicular to afford the operator a full view of the egg chamber without stooping or kneeling. It is not a view of the wooden edge of the tray that the operator wants; it is a view of the thermometer, the eggs, or the chicks. The glass should be located so as to permit this view, but if the glass is too narrow or not properly placed, or if the

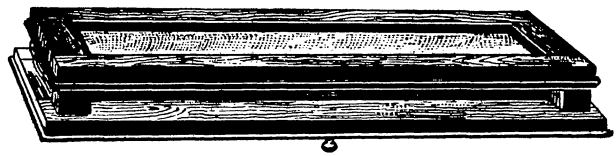

FIG. 5.—An up-to-date door.

margin of the sash is too wide, the window will be of little value to the operator. This matter is worthy the attention of the manufacturer, for there is quite a prejudice against a machine the temperature of which can not be watched without the removal of the thermometer from it. Many manufacturers send machines with doors imperfectly fitted, the glass of which is covered with paint, putty, or varnish, which can not be removed, and it is impossible to read the thermometer through such doors. Once more purchasers are warned to avoid the machine that will not permit them to read the thermometer without opening the door. Manufacturers should bear in mind that the light should strike the egg tray from above instead of from below.

Thermometer.—It is really surprising that up to the present time so little improvement has been made in thermometers. An instrument of this kind should be plainly legible and it should be convenient to handle. The usual practice of glazing the back of the tube with white porcelain makes the reading of the temperature very difficult. There seems to be no good reason for this. This white background makes a grayish shade, the color of the mercurial column, and unless the light is very good and strikes the figures from

the right direction it is almost impossible to ascertain the temperature without removing the thermometer from the machine. This is bad, as the column is likely to contract or expand while being conveyed to the light. The column should be large enough to be seen from a distance of at least 4 feet, and the markings and figures should be few and very plain. Many of the frames in which the glass is set are cumbersome, take up too much room, obscure the view, have sharp corners or long legs to catch upon the tray or sleeve, and yet are too unstable to stand alone or stay where placed. A thermometer with a red or green background, a large mercurial column, a few plain marks and figures, and mounted upon a convenient yet substantial frame will be a boon to poultry men. Improvements will be made, and it is well for purchasers to ask for the latest and the best. In connection with thermometers it is well to state that the so-called "magnifying lens" is a failure and much more difficult to read than the plain round tube unless it is held in exactly a certain position with reference to the light. The thermometer tube need not be over 4 inches long, and the less metal it has attached to it the better. In regard to the accuracy of the thermometer, almost any physician will test it for you by the side of his clinical thermometer, which has about the same scale and range.

Regulator.—Many are the methods that have been tried for automatically regulating the temperature of the egg chamber. So far all of them depend upon the principle of contraction and expansion. The demand is for some simple device that will allow the temperature to rise so high and no higher, and that will maintain the temperature at that degree regardless of the weather or external influences. Most regulators act upon a damper over the top of the lamp, and, by opening or closing the same, regulate the amount of heat that passes into the incubator. The expanding horseshoe-shaped bar, the elliptical spring bar, and the metallic disk are the most common regulator powers of the present. Perhaps in the course of time some one will make a regulator from a coil or spiral spring that, reaching clear across the top of the egg chamber, will very accurately control the admission of heat.

At the present time the best regulator is the double disk, whether filled with air or with liquid. Excellent results are obtained by using the single disk, but the double disk is still better. The disk, in order to be useful, should be large enough to have some force and to note the slightest variation in temperature. A disk of only 1 or 2 inches diameter has hardly power enough, nor is it delicate enough for quick and perfect action. The writer prefers the double disk and that with a diameter of 4 or 5 inches. Such disks will be very susceptible to changes in temperature and will be strong enough to act

upon the damper. Of course there are machines that use the horseshoe or buggy spring expanding bar, which work fairly well; but as fast as possible the writer has these attachments removed and the disk substituted for them. Many purchasers have no patience with a regulator that will not work from the start, and, owing to the fact that first impressions are prejudicial, it is safer to ship articles that will go together readily and work from the start. There is something in the location of the regulator. The disk should be placed near the center and well toward the back of the egg chamber. It should be placed so high that it is not in the way of the eggs or the tray. Another reason for placing the disk high is that, because the chicks as they hatch will tumble around more or less before dropping into the nursery, one or more of them may hit the regulator, thus disturbing its adjustment and bringing disaster to the remainder of the hatch. The regulator should be strongly fixed in its bearings, so that an accidental touch will not put it out of order.

Most machines have the long bar or damper lever upon the top of the body. This is a serious fault. The top of the machine is the most convenient table for cooling, testing, or turning eggs, and it should be free and clean for that use. Besides this, the lever, when located outside and upon the top of the machine, is easily affected by a current of air and also liable to become bent or dislocated. A child, a stray fowl, a mouse, a cat, or a slight breeze will be likely to interfere with the action of the regulator if it is exposed upon the top of the incubator. Some makes of incubators have the damper lever at the end of the case; others have it above the egg chamber, where it is covered and protected. The adjustment of the regulator should be perfect and accurate. Threads should be true and cut to fit the bur; rods should be of proper length and, if weights are used, they should be so arranged that they can be fixed in the proper position. The writer sees no use for the weight, nor does he favor a very long lever. By principle of direct action the damper is its own weight, and with the disk regulator no other weight seems necessary. In some machines the regulator is cumbersome, takes too much space in the egg chamber, and interferes with the handling of the trays; in others it is loosely set and constantly getting out of balance and dropping down upon the eggs or chicks. The disk regulator is less in the way and less liable to fall down than any other that the writer has used. Figure 6 shows a good regulator.

Few machines are perfect in all their parts, but when one is found that suits in most details it is kept and remodeled to suit everyday requirements. Most manufacturers make a mistake in their failure to test every machine as a whole before sending it out. Made of the same materials, from the same patterns, by the same machinery and

the same workmen, all mechanical products are liable to vary somewhat in their action. Each incubator has an individuality, and it requires a thorough test at the factory.

The purchaser can feel assured that plenty of incubators are now made by firms that test them in the shops and whose regulators can be relied upon as surely as can a watch or clock. Defects have been mentioned for the good of both manufacturers and purchasers, as the author firmly believes the incubator to be a staple article of manufacture and use, and a money maker for the intelligent and persistent operator.

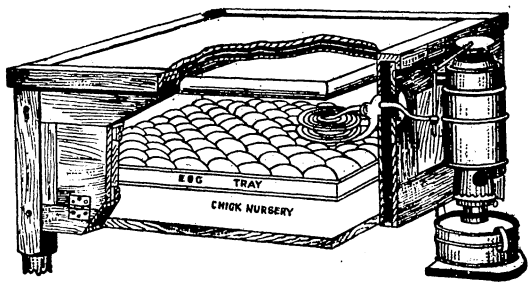

FIG. 6.—A good regulator.

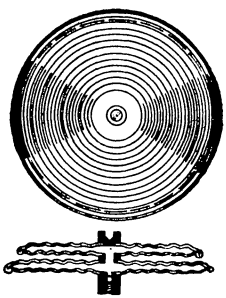

FIG. 7.—Thermostat—front and sectional view.

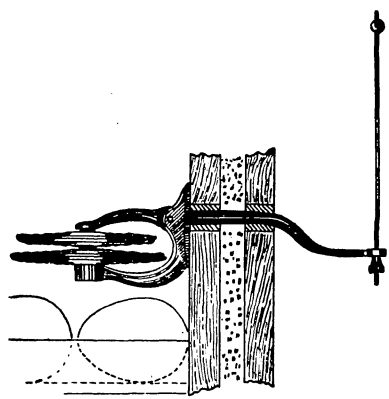

FIG. 8.—Thermostat—side and sectional view.

Ventilation.—So much has been written upon the subject of ventilation that the reader need not expect the writer to add much that is new to the literature upon this subject. One thing is sure, namely, that in nature the mother hen is compelled to allow fresh air access to her eggs. But she frequently makes her nest in places where the air is far from good, and yet she gives us a fair hatch regardless of atmospheric surroundings. It is not likely that frequent currents of fresh air over the eggs are necessary to successful incubation, nor does it seem certain that air in motion, even if it has been warmed, is inclined to promote hatching. If the machine is opened twice a

day and the eggs taken out to be cooled or turned, they get about all the ventilation they really need. But accidents may happen; there may be leaking of steam or smoke, or a breaking of an overlooked decomposing egg, and, for fear that such an accident may happen between the hours of inspection, it is well to have a system of moderate ventilation in operation. One of the best methods is a circular hole in the bottom of the machine, this hole being about 1½ inches in diameter and covered with fine wire screening on the inside and provided with a slide of tin or other metal upon the bottom or outside. This slide should be open when the machine is first heated. It should work easily and be slightly open all the time, and should be altered according to the weather. One thing often overlooked is the quality of the air in the room occupied by the incubator. The room should be clean, free from dust and mold, moderately dry, and contain air of absolute purity. This has more to do with the condition of the air in the egg chamber than many are inclined to admit, and is, in the writer's opinion, the major part of ventilation.

Moisture.—This is another topic that has been freely discussed in the poultry journals. A great many different plans have been advocated for keeping the air in the egg chamber properly charged with water. The simple plan of placing in the bottom of the egg chamber a saucer containing a small wet sponge is as good as any. There does not appear to be any better method than this of rendering the air around the eggs humid. The amount of moisture required is so little and varies so much under different circumstances that the ingenuity and judgment of most operators can be relied upon to provide moisture as needed. If the incubator is operated in a cellar or basement, the air will probably be damp enough without the further introduction of moisture into the egg chamber.

SUMMARY OF THE DEFECTS OF INCUBATORS.

The following summary of faults most frequently found is here appended: Poor material, poor workmanship, and poor arrangement are all to be condemned. Machines of poor construction, or constructed out of refuse material from other lines of manufacture, will no longer satisfy the up-to-date poultry man. Incubators made out of the odds and ends of other goods, or with coarse, dull tools, are no longer in demand. Machines made by men who know nothing about the poultry business, or who take no interest in that business and lack experience in operating incubators, are likely to prejudice the public against the use of all incubators. The inspector should be competent. If he does not know how to test every part of a machine and exercise thoroughness in his work, one can hardly expect the output of his factory to give satisfaction.

SUMMARY OF THE GOOD POINTS OF AN INCUBATOR.

On the other hand, good material, good workmanship, and adaptability of parts, or such arrangement of the various parts of the machine as shall make it efficient, practical, and convenient, are desirable. Two dead-air spaces, good strong legs, plenty of space in the egg chamber, good windows properly placed, a good thermometer located where it can be read without disturbing the machine are all necessary and among the strong points of a good incubator. In addition to these, there are a good lamp—one with a good burner and good chimney—a good regulator, a good strong tray properly placed, and a good

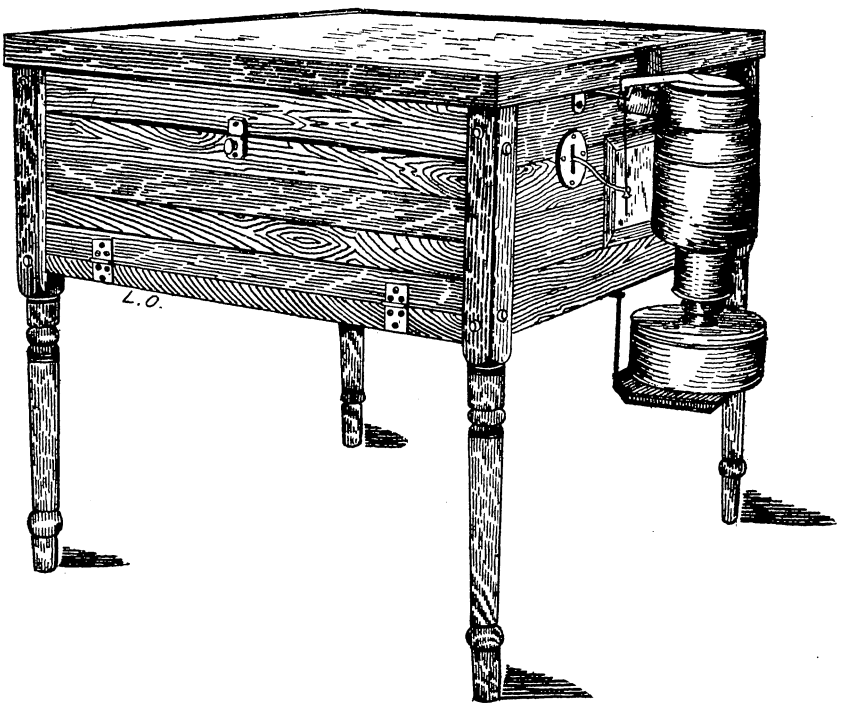

FIG. 9.—A first-class hatching machine.

roomy removable nursery tray below. All chips and shavings should be removed when the machine is inspected or before shipment. Makers of incubators must not lose sight of the fact that the construction of an incubator is a living problem. It has to do with the promotion of life and is not a mere matter of iron and wood. This business requires more skill and better workmanship than does the construction of thrashing machines and fanning mills. This machine operates upon living products and it must bring forth living creatures, else it is useless.

Purchasers should be cautioned against buying an incubator of large size for experimental or farm work. The so-called 100-egg size is large enough for the beginner. One tray and one egg chamber are enough.

HOW TO OPERATE AN INCUBATOR.

The agricultural papers and poultry journals are full of information upon the management of incubators, and many books have been published to furnish instruction upon this subject; but a great many farmers do not see these journals or the books. Once let it be known that the operation of an incubator is easy and simple, and once the almost superstitious dread that some people have of taking up something new is overcome, there will be little trouble in teaching the uses and management of the common hatching machine.

At the outset the writer insists that the successful operation of an incubator depends upon accuracy and exactness. Not only should the work be done properly, but it must be done "on time." The woman who fills her lamps at a certain hour of the day, and the man who winds his watch or clock at the same hour every evening, need not fear the task of running an incubator. But unless one is willing to study, to read, and to practice, and is willing to attend to the few wants of his machine at the right time, making a specialty of promptness and punctuality, it will be unreasonable to look for chickens from the best incubator under his management.

FIG. 10.—One of the best incubators.

The person who runs an incubator must be clean and careful; he must be at home with his machine at the same hour every morning and the same hour every evening; he must learn the peculiarities of his incubator and carefully follow instructions. For such a person the operation of the ordinary hatching machine will be simple and easy enough. With each shipment the manufacturer sends out a book or card of directions. Read this carefully before attempting to set up the machine. Put the parts together in exact accordance with

these directions. Count the parts and inspect them carefully; then put them together; see that the machine stands level; that the doors open and shut easily; that the regulator is in working order.

About this time comes the question, Where shall we set this machine? This matter of location is very important. It has much to do with success in hatching. First, it must have some permanency. It must be placed where it will not be disturbed, away from jars and vibrations, out of all drafts or where the breeze can not strike it and where the opening and closing of doors and windows will not affect it. The room occupied must be large enough and have a level floor. One needs room to work about an incubator. It should have a clear space around it, especially in front, and at the lamp end of the machine there should be plenty of room. The apartment should not be damp or dark. A clean, dry, light cellar is excellent for this purpose. Any dry, clean room will do, but, as before stated, drafts or currents of air over or around the machine are very detrimental. There should be no stove or other source of artificial heat in the room occupied by an incubator. The entire room should be clean and free from dust. Some of these items have been mentioned in the preceding lines, but their importance warrants a repetition here.

Common sense and circumstances will dictate the location of the machine, but the above suggestions will be found worth considering. One thing is certain, if the incubator is not afforded proper quarters it can hardly be expected to give good results. The room decided upon, the machine set up, its parts adjusted, and its level taken, it is now in order to clean, trim, and fill the lamp. The wick should be dry-trimmed with a pair of sharp shears before it is inserted in the burner. Then after being passed up and down the tube a few times it should be trimmed again and its corners slightly nicked or rounded. Now is the time to prove whether the burner is in perfect order and that the wick works freely and easily. The wick should now be moistened in kerosene and drawn back to its proper position for lighting. All dust and moisture should be wiped from the burner. Especially important is it that the start be made with a clean tube and sieve. The lamp should be filled within one-fourth of an inch of the top, and then after the burner is attached to the lamp the whole should be cleaned with a dry, clean cloth. The chimney also should be carefully cleaned with a dry cloth. It should be free from dirt, dust, or grease. If the chimney is not kept perfectly clean the lamp will smoke, and a smoky lamp means a poor hatch. Dry cleaning cloths should be set apart for this purpose. All these details looked after, the lamp can be lighted and placed in position if the machine is a hot-air machine; but if it is a hot-water machine the lamp must not be lighted until

the tank is filled with water in accordance with the instructions that accompany the machine. Study the structure of your lamp and exercise great care in putting it together as well as cleaning and filling it the first time. Familiarity gained and habits formed will be of value to the operator in the future management. Accuracy and thoroughness are important.

Use nothing but the best grade of oil. No incubator will do good work with poor kerosene. The best will cost less in the end. It will give more heat, less smoke, and make less dirt and less work. If oil is bought by the barrel do not accept it in an old barrel. It may be short in measure or it may contain water and rubbish in the bottom of the barrel.

With the incubator in its place, all parts adjusted, the tank, if any, filled with water, and the lamp lighted and wick turned up so as to give a clear, white flame—just high enough, but not too high—we are ready to balance the machine or to establish the ratio between the thermometer, the regulator, and the lamp.

The incubator should be run with the trays empty for at least twenty-four hours before the eggs are placed in the egg chamber. This gives it a chance to get well warmed throughout, and it also gives the operator time and practice in adjusting the regulator so that it will keep the egg chamber at the proper temperature. This temperature should be exactly 100° F. for several hours before the eggs are put into the egg chamber. All this time the lamp should be kept in order and made to burn with a clear, white flame, so that it does not smoke and so that it can be turned a little either up or down without smoking. This is essential. The blaze must be good from the start and the regulator balanced to a good flame, and this must be done before the eggs go into the egg chamber. It is easier and safer to experiment with the lamp and the regulator when the egg chamber is empty than when the machine is full of eggs. A few hours spent in adjustment will be time saved later on. Nearly every machine is accompanied by a card of directions for operating it, which should be studied and followed.

It is not the province of this article to explain the individual peculiarities of the regulators of different makes, but rather to show what results are to be sought. The damper over the top of the chimney should be kept free from the chimney, say about one-eighth of an inch of space being left between or around the margin of the damper. If you are using a hot-water machine, allowance must be made accordingly and leakage looked for before setting the eggs. The general principle, so far as the regulator and the lamp are concerned, is the same in all machines. At the end of the experimental twenty-four hours, again fill the lamp and trim the wick, and with the machine

running steadily at 100° F. the egg tray, loaded according to directions given below, can be placed in the egg chamber. The eggs should be clean and dry and should have been prepared and balanced as suggested in the early part of this article. When filling the trays put in eggs enough to fill completely every space, with every egg lying upon its side. Do not stand the eggs upon end nor pile them one upon another. The filled tray being now placed in the egg chamber, close the door, being careful not to slam it and so disturb the regulator or the lamp. The machine can now be left by itself an hour. At the end of that time visit it, and if the thermometer still stands at 100° leave it again for another hour. At the third visit it may be necessary to turn the regulator thumbscrew, or the wick may need raising or lowering a little. It will be a matter of judgment at first whether you change the wick or the regulator. In most cases, if the blaze is about right, it is best to leave it so and to more completely balance the machine by a slight manipulation of the regulator, for if this is nicely done upon the start the temperature can be controlled during the entire period of incubation by slightly turning the wick. Note the repetition: Have your flame to suit you at the outset, leave it so, and adjust the regulator accordingly.

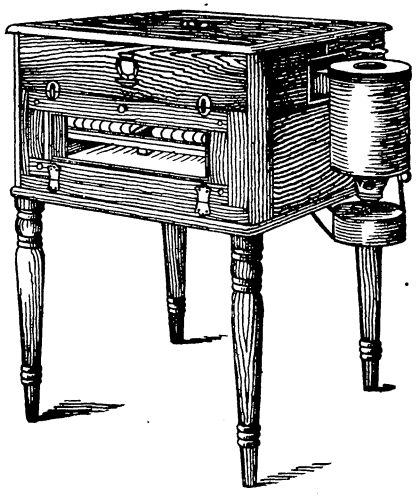

FIG. 11.—A well-made incubator.

It takes twenty-four hours properly to test the lamp and adjust the regulator. During this time the eggs are gradually warming up, and the operator is supposed to be watching the machine and studying his instruction book. If a hot-water machine is used, some allowance must be made for the time occupied in warming the tank, unless it is filled with water already warmed. Let the operator bear in mind that each incubator has its own peculiarities and must be learned and managed accordingly. Another thing to note is that the manufacturer of an incubator is likely to understand its management and the operator is quite safe in following the printed directions for setting up and starting the machine; but, while the manufacturer understands the mechanical details of the construction and adjustment of his goods, his notions about the future management of his or any other machine may not be at all like, nor at all superior to, those of some other manufacturer. This is illustrated in natural incubation.

One farmer sets all his hens in straw nests, another sets them all in chaff nests, another sets them all upon the ground and in earth nests, but the results are about the same. Methods may seem to differ and yet results may be very much alike.

The hatch can now be said to be begun. The incubator has been set up, adjusted, and tested under heat for twenty-four hours. It has been found capable of maintaining an even temperature, and the eggs are already warm in the egg chamber. The thermometer has been placed at a level with the top of an egg near the center of the tray. At first the work will require a few visits at intervals of not more than one hour apart, but after the third of these, if everything seems all right, the machine can be left alone for three or four hours, but the operator should be sure to visit it just before he retires for the night. On the morning of the second day the temperature should have risen to 102° F. It must not be forgotten that from now on the eggs will manifest a little heat of their own and this must be considered, as it will influence the action of the regulator. Or, in other words, if the egg is fertile the germ will begin to waken into life and possess and give off heat. This lessens the work of the lamp and should make the operator cautious in his manipulations of the regulator. The temperature from now on should be kept at 103° F. If the machine is balanced right, a very slight turn of the regulator button or of the wick elevator is all that will be required. The operator must not become overanxious now; he should resist all temptation to tamper unnecessarily. It is better to change the adjustment but a mere trifle and then wait a little to observe the result than to make great and abrupt changes. It is very easy to cook the eggs and quite as easy to chill them. All changes should be gradual, and the machine always be under the control of the operator. Once in good working order, the less an incubator is disturbed the better. From now on it should be visited at regular intervals, three times a day—morning, noon, and night. At the same hour every morning the wick should be trimmed, the chimney cleaned, and the lamp refilled. The visit at noon is simply one of inspection and observation. At this visit the operator should look first at the thermometer and then at the lamp. If the temperature is right and the lamp is burning well, there is nothing more to do.

Returning to the work of the morning after, the lamp is cared for and started again, the operator should watch it carefully for a brief period. Then, if the thermometer shows the proper temperature, it is in order to turn the eggs. During turning the tray should be removed from the egg chamber and the door closed. Some of the details of turning have been given. The hand should be clean and the eggs gently rolled around. It should not require much time to

turn the eggs, three or four minutes being sufficient. As a rule no other cooling is necessary, but this subject will be referred to later on. Many devices have been invented for turning the eggs, but the simple method of turning by hand is sufficient. Gently brush or roll them around or change them from one side of the tray to the other. The necessity for turning depends upon the fact that unless the egg is turned, its substance will gravitate, the egg will become too dry upon one side, and the chick will become attached to this dry side. Such an event will result in a dead or deformed chick. The whole process of turning is so simple that further explanation seems unnecessary. As to how frequently they should be turned, once a day is sufficient, though many practice turning twice a day. This turning should be continued from the third until the nineteenth day. After the usual signs of hatching can be heard the eggs must not be moved or disturbed. After the nineteenth day the rule "do not turn them," is imperative. The chick, ready to break its way out, has found its proper position, and to move the egg may so place the chick that it can not work to advantage or that it will drown or smother.

Cooling.—Many successful poultry men pay little attention to cooling the eggs further than to take plenty of time in turning. Much depends upon the machine, and more upon the condition of the atmosphere. If not exposed to draft or sunlight, the eggs can be left outside the machine for fifteen or twenty minutes and be none the worse for the exposure, but, as a rule, an exposure of five minutes is sufficient. That some cooling is necessary seems borne out in natural incubation by the practice of the hen, which leaves her nest from ten to sixty minutes every morning. Of course, the hen may do this for her own accommodation, but it seems to be part of the programme in natural hatching, and better results are obtained when the eggs are cooled somewhat every day. This practice of cooling should be continued to the eighteenth day. Right here it may be well to advise the inexperienced operator to keep the egg chamber closed after the evening of the eighteenth day and until the close of the hatch.

Moisture.—This subject is one upon which opinions differ vastly. In the opinion of the writer much depends upon the incubator, its location, and the external atmosphere. All agree that a certain amount of moisture is needed. In natural incubation the hen leaves her nest early in the morning, while the dew is yet upon the grass, and if caught upon her return to the nest her feathers will be found to be wet. Yet some of the most successful hatches have been made by hens that were not allowed to leave the hatching pen. Hence the argument is not settled. But, from the fact that the early morning atmosphere is damp and the eggs are exposed to this moist atmosphere

while the hen is off the nest, it is safe to infer that a limited amount of moisture is essential. If the incubator stands in a damp cellar, a very good hatch can be made without the introduction of any moisture into the egg chamber; while upon the other hand, if the machine is located in a dry room and the weather is dry, a poor hatch can be expected if no moisture is supplied. Many different methods of supplying moisture have been suggested, but most experienced operators incline to the simplest methods. A small sponge saturated with pure water can be placed in the egg chamber and allowed to remain there overnight, or a saucer containing a little water can be placed in the bottom of the egg chamber and left from time to time, or the hand of the operator can be dipped in warm water and brushed lightly over the eggs just before they are returned to the machine in the morning. The last seems to be a natural method and does not overcharge the egg chamber with moisture. Too much moisture will ruin the hatch, and it is better to err upon the side of too little than too much. A good rule is to note the barometer and in damp weather supply very little moisture. As to what is meant by much or little moisture, the writer thinks that a teaspoonful of water is plenty for 100 eggs in wet weather, while in dry weather an ounce is none too much, this being for a period of twenty-four hours. Or, again, if the machine stands in a cellar, a teaspoonful of water will last 100 eggs three days, while in a dry, well-ventilated room a tablespoonful of water every twenty-four hours will do no harm. The water supplied must be clean and pure and should be warm when it is introduced. Surely with these few hints the operator ought to be able to settle the moisture question for himself.

Testing.—The egg will show signs of hatching within thirty hours of its first exposure to heat. Along about the twenty-eighth hour a point denoting the head and another denoting the heart will appear. About the forty-fifth hour the expert can detect a slight motion of the heart. In about seventy hours the membrane known as the allantois is visible. This envelope is the temporary breathing apparatus of the chick. On the fifth day the streaks denoting the limbs can be seen. On the sixth day the liver can be located, and a slight voluntary motion is observable. By the seventh day the lungs, stomach, and brain show development; the eyes can be found by the tenth day; and on the twelfth day feathers begin to form. The bill opens and shuts by the fifteenth day, and the cry of the chick is heard about the eighteenth day. Soon after, or early in the nineteenth day, the chick bursts the air cell at the end of the egg and begins to use its lungs in breathing. From this time it grows rapidly and soon becomes strong enough to break through the shell.

While the process of hatching is very interesting, the practical

operator need not concern himself with minute details. The eggs should be tested at least three times during the period of incubation. First, as a matter of economy. Eggs not fertile will not spoil for a few days, and they will be as good for the table or feed after a few days in the incubator as after as many days in the nest. Again, eggs that are doubtful can be cooked for food for young chicks or cooped fowls. Another reason why nonfertile eggs should be discovered and removed is that they absorb some heat from the air of the egg chamber and generate none of their own. Again, if nonfertile eggs happen to be old when placed in the tray they are liable to decompose, and, by giving off poisonous gases, foul the air of the egg chamber and poison the chicks in the good eggs. However, it is not wise to disturb the eggs too frequently. Testing upon the seventh, the tenth, and the fourteenth days is quite sufficient. All nonfertile and all doubtful eggs should be removed from the machine as soon as their condition is detected.

The process of testing is simple enough after a little experience is acquired. It depends upon the appearance of the egg when it is held between the eye and a light. In order that the view may be most advantageous, it must be contrasted with a dark border. Many different egg testers have been devised, but they all depend upon the above principle. The simplest in construction is a plain tube about 1½ inches in diameter and made of tin, wood, or cardboard. The egg is placed snugly against the opening in this tube, and it is so held that the egg is between the tube and the light and the tube is between the egg and the eye. With the eye close to the uncovered end of the tube, a picture of the egg can be seen through the transparent shell. If the test is made in a dark room, a much better view can be obtained. A very fair test can be made in a dark room by holding the egg before a small aperture in a window shade, provided the sun is shining against the window. In cloudy weather, when the sun can not be depended upon, some kind of an egg tester is required. All manufacturers furnish some kind of egg tester with every machine sent out, and the most of them work upon the same principle and are operated in the same way. Evening is the best time for making the test. Have ready a low table and an empty tray, also a basin or a basket. The operator can work best if seated at the table with the lamp in front of him; upon his left is the tray of eggs to be tested, with the empty tray and basin upon his right. Every detail should be arranged before the eggs are removed from the egg chamber, as a prolonged exposure is to be avoided. One by one the eggs are taken from the tray, tested as above suggested, the appearance observed, and the egg, if fertile, placed in the empty tray, or, if infertile, placed in the basket. As soon as all are tested the tray containing the fer-

tile eggs is replaced in the incubator, the door of which is then closed and the machine left as before. Experience soon teaches one the appearance of the nonfertile and the spoiled egg, as contrasted with that of the fertile egg which has already begun to hatch. The fertile, or hatching, egg will show a spiderlike formation, a center with long crooked threads, or rays, leading outward, and this formation will float as the egg is turned, seeming to have an inherent power of motion. Such eggs are good and the germ is alive and hatching. But if this formation is a black stationary spot and the red lines come together in a circle, the egg is one that has been fertile, but the germ of which is now dead. Such an egg should be removed from the tray at once. The egg that remains clear except for a small dark cloud is infertile and may possibly be used in cooking. In case an egg is doubtful it can be marked and returned to the tray and left there a few days to be tested again. All eggs that cool too quickly should be marked for special examination, and remember that the egg that does not contain life will be cooler than the live egg. Cracked eggs can be saved by the use of court plaster, but unless it be from a rare or valuable fowl the attempt to hatch a broken egg will hardly be worth the trouble. At the second testing, about the tenth day, the eggs that are hatching well will be nearly half darkened, while the others will look more or less as they did in the first test. On the seventeenth day the chick will be seen to fill all the egg but the air space, unless it has died in the shell since the previous testing. The final testing should be carefully made and with the shortest possible exposure.

The air cell.—Books upon incubation devote much space to this subject. The writer thinks it cuts but little figure in the work of the operator. If the air cell is too large the egg is too dry, while if not large enough the egg is too moist, and the moisture supply can be governed accordingly. Experience will teach the operator much more about the air space than will written pages, and until he is experienced he need not attach very great importance to it unless it be unusually large or small. By the end of the sixteenth day this occupies about one-fifth of the space in the egg, and the chick ought to occupy the remainder of this space. The air cell gradually increases until the eighteenth day. Upon the eighteenth day, or the nineteenth day at most, the eggs are turned and cooled for the last time. After this do not disturb the eggs. If necessary, partly close the ventilator slide. Leave the door closed. Of course, the thermometer must be watched and the lamp filled and trimmed more carefully than ever. Do not be alarmed if the thermometer shows a temperature of 104° at this time. No harm will be done if the eggs are kept at that temperature a few hours.

The operator is again cautioned to let the eggs alone during the last two days of incubation. If the door must be opened to rearrange the thermometer or to supply moisture, it should be for a brief period only, and great care should be exercised not to jar nor change the positions of the eggs. But the lamp should be kept in good order and the regulator and thermometer watched closely. Some of this has been stated before, but it will bear repeating, for many a good hatching prospect has been blighted by overanxiety or curiosity.

At the end of the twenty-first day open the door and pull the tray partly forward. Then remove the shells and, if any chick is found with the shell dried upon it or in any way attached to it, carefully liberate the chick and place it in the nursery below. Then carefully close the door and let the machine alone for another six hours unless the eggs are all hatched sooner.

The eggs about all hatched, now is the time to clean and set up the brooder, which should be heated a few hours before the chicks are removed from the nursery. After the hatch is completed and the chicks are removed from the nursery, the machine should be taken apart, carefully cleaned, and set right for future use. The brooder should be started at about 98° F. and gradually lowered at the rate of 1° a week, according to the weather and the experience and judgment of the poultry man.

The chicks should not be fed until they are thoroughly dried and have been out of the incubator at least twenty-four hours. The first feed should be fine sharp grit or sand, upon which is sprinkled a very little hard-boiled egg chopped fine. After this they should be fed every three hours a little broken grain or, better yet, some of the excellent prepared dry chick foods upon the market. Clean, fresh water should be supplied from the start. Wet, sloppy food should be avoided. If none of the manufactured chick foods are at hand, a substitute can be made by cracking a mixture of wheat, corn, and egg shells. Any good poultry journal will give valuable hints upon the subject of raising chickens in brooders.

SUMMARY.

Study your incubator.

Acquaint yourself with all its parts.

Read the manufacturer's directions for setting it up.

Set it up carefully and according to instructions.

Never try to run an incubator in a drafty place, nor near a stove, nor where the sun shines upon it.

Set fertile eggs only. Waste no effort upon those that are doubtful.

Learn how to trim and clean a lamp.

Keep the lamps full and the wick and tube clean.

Avoid smoke.

See that the eggs are clean and dry before setting them.

Balance all eggs, large end up, a few hours before placing them in the tray.

Do not overfill the tray.

Turn every egg the third day.

Cool the eggs every morning.

Be sure your hands are clean when handling eggs.

Test all eggs by the seventh day.

Test again by the eleventh day.

Test again by the fifteenth day.

If the air space is too large, supply moisture; if too small, put a saucer of dry lime in the room and run without moisture a day or two.

Do not expect to learn all about the air cell the first hatch. You will learn that later.

Do not disturb the eggs after the evening of the eighteenth day.

Have a regular hour for incubator work.

Do not tinker too much with the regulator.

Get the adjustment right and keep it so.

Heat your machine and make your adjustment before placing the eggs in the egg chamber.

GENERAL REMARKS.

The average farmer, his wife, his son, or his daughter, should not expect to learn all about the management of an incubator from the perusal of written pages. Experience comes from the work itself. This work is easy, interesting, and fascinating. It occupies the mind and leads to investigation. More than that, it leads to success and profit. But great results can not be expected in the beginning. The poultry business is a trade and must be learned. Many a person is idle to-day and looking for some sphere of usefulness who could learn how to operate an incubator to both mental and financial advantage. But the work, slight as it is, must be done properly and at the right time. The poultry business is honorable and profitable, but it requires study and experience. We serve a long and faithful apprenticeship to learn other more laborious and less remunerative trades, when the same amount of application would in less time make us experts with an incubator and give us a trade in a line not affected by strikes or lockouts, or liable to be overcrowded.

FARMERS' BULLETINS.

The following is a list of the Farmers' Bulletins available for distribution, showing the number and title of each. Copies will be sent to any address on application to any Senator, Representative, or Delegate in Congress, or to the Secretary of Agriculture, Washington, D. C.

No. 22. The Feeding of Farm Animals. No. 24. Hog Cholera and Swine Plague. No. 25. Peanuts Culture and Uses. No. 27. Flax for Seed and Fiber. No. 28. Weeds: And How to Kill Them. No. 29. Souring and Other Changes in Milk. No. 30. Grape Diseases on the Pacific Coast. No. 32. Silos and Silage. No. 33. Peach Growing for Market. No. 34. Meats: Composition and Cooking. No. 35. Potato Culture. No. 36. Cotton Seed and Its Products. No. 37. Kafir Corn: Culture and Uses. No. 38. Spraying for Fruit Diseases. No. 39. Onion Culture. No. 41. Fowls: Care and Feeding. No. 43. Sewage Disposal on the Farm. No. 44. Commercial Fertilizers. No. 46. Irrigation in Humid Climates. No. 47. Insects Affecting the Cotton Plant. No. 48. The Manuring of Cotton. No. 49. Sheep Feeding. No. 50. Sorghum as a Forage Crop. No. 51. Standard Varieties of Chickens. No. 52. The Sugar Beet. No. 54. Some Common Birds. No. 55. The Dairy Herd. No. 56. Experiment Station Work—I. No. 57. Butter Making on the Farm. No. 58. The Soy Bean as a Forage Crop. No. 59. Bee Keeping. No. 60. Methods of Curing Tobacco. No. 61. Asparagus Culture. No. 62. Marketing Farm Produce. No. 63. Care of Milk on the Farm. No. 64. Ducks and Geese. No. 65. Experiment Station Work—II. No. 66. Meadows and Pastures. No. 68. The Black Rot of the Cabbage. No. 69. Experiment Station Work—III. No. 70. Insect Enemies of the Grape. No. 71. Essentials in Beef Production. No. 72. Cattle Ranges of the Southwest. No. 73. Experiment Station Work—IV. No. 74. Milk as Food. No. 77. The Liming of Soils. No. 78. Experiment Station Work—V. No. 79. Experiment Station Work—VI. No. 80. The Peach Twig-borer. No. 81. Corn Culture in the South. No. 82. The Culture of Tobacco. No. 83. Tobacco Soils. No. 84. Experiment Station Work—VII. No. 85. Fish as Food. No. 86. Thirty Poisonous Plants. No. 87. Experiment Station Work—VIII. No. 88. Alkali Lands. No. 91. Potato Diseases and Treatment. No. 92. Experiment Station Work—IX. No. 93. Sugar as Food. No. 94. The Vegetable Garden. No. 95. Good Roads for Farmers. No. 96. Raising Sheep for Mutton. No. 97. Experiment Station Work—X. No. 98. Suggestions to Southern Farmers. No. 99. Insect Enemies of Shade Trees. No. 100. Hog Raising in the South. No. 101. Millets. No. 102. Southern Forage Plants. No. 103. Experiment Station Work—XI. No. 104. Notes on Frost. No. 105. Experiment Station Work—XII. No. 106. Breeds of Dairy Cattle. No. 107. Experiment Station Work—XIII. No. 108. Saltbushes. No. 109. Farmers' Reading Courses. No. 110. Rice Culture in the United States. No. 111. Farmers' Interest in Good Seed. No. 112. Bread and Bread Making. No. 113. The Apple and How to Grow It. No. 114. Experiment Station Work—XIV. No. 115. Hop Culture in California. No. 116. Irrigation in Fruit Growing. No. 118. Grape Growing in the South. No. 119. Experiment Station Work—XV. No. 120. Insects Affecting Tobacco. No. 121. Beans, Peas, and other Legumes as Food. No. 122. Experiment Station Work—XVI. No. 123. Red Clover Seed: Information for Purchasers. No. 124. Experiment Station Work—XVII. No. 125. Protection of Food Products from Injurious Temperatures. No. 126. Practical Suggestions for Farm Buildings. No. 127. Important Insecticides. No. 128. Eggs and Their Uses as Food. No. 129. Sweet Potatoes. No. 131. Household Tests for Detection of Oleomargarine and Renovated Butter. No. 132. Insect Enemies of Growing Wheat. No. 133. Experiment Station Work—XVIII. No. 134. Tree Planting in Rural School Grounds. No. 135. Sorghum Sirup Manufacture. No. 136. Earth Roads. No. 137. The Angora Goat. No. 138. Irrigation in Field and Garden. No. 139. Emmer: A Grain for the Semiarid Regions. No. 140. Pineapple Growing. No. 141. Poultry Raising on the Farm. No. 142. Principles of Nutrition and Nutritive Value of Food. No. 143. Conformation of Beef and Dairy Cattle. No. 144. Experiment Station Work—XIX. No. 145. Carbon Bisulphid as an Insecticide. No. 146. Insecticides and Fungicides. No. 147. 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